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Cardiovascular health maps for health positioning and optimize interventions

Statement of the Problem: Several studies attempted to predict patient's deterioration or progress using a combined score. However, since the combined score is just numeric value that combines many parameters, it does not provide the multidimensional health status or where to go from here, how to evaluate alternative treatments, etc. Medicine in general including cardiology, does not have one acceptable and explicit framework that defines the position of a patient in the cardiovascular health space, her/his target zone and paths (interventions) from the current position to the target. This makes it difficult to decide about the costs/benefits of each alternative treatment and even more to quantify effectiveness and visualize it in a way that both the doctor and the patient can understand it. According to this approach we use the BP pulse shape as indication to the cardiovascular status of the patient and create a continuous space spanned by its N dimensional features.

Method: The theoretical framework we suggest is that of fuzzy sets, where each patient get different level of membership in different pathological and healthy conditions i.e. we view health and sickness in different diseases as a continuous space, where subjects do not fall into one category or another but are points in this continuous space. Their position defines their health condition in a certain moment in time and changes dynamically with the interventions. The methodology was to do a multi-center study, record the BP pulse wave continuously over long periods of time and in parallel use continuous or frequent BP measurements. In one clinical study in Fresenius Kidney Care, St. Louis the trial was done on 14 patients, each patient had 2-4 sessions and each session was about of 4 hours. PPG (Photoplethysmogram) has been recorded continuously by a watch with finger optical sensor probe and compared to CNAP continuous hemodynamic monitor. In another clinical study done in a Calcutta hospital for hypertensive and diabetic patients, we used the same watch for continuous recording of PPG and use ABPM (Ambulatory Blood Pressure Monitoring) every 15 minutes for 24 hours on hypertensive and diabetic patients. In a third center in Meir Hospital in Israel, recording with the same watch was done during stress tests, where each 2 minutes BP is measured and ECG is measured continuously. Also, cardiac output has been measured in the beginning and end using echocardiography. Using 2-4 light wavelengths allowed us also to interrogate the capillary bed at different penetration levels to estimate features related to the microcirculation.

Findings: In all the three studies which provided tens of thousands BP measurements with simultaneous BP pulse shapes, we did fuzzy clustering algorithm we developed to cluster the pulse shapes in the N dimensional feature space and minimize dimensionality by looking for the smallest dimensionality space and its 2D projections. By doing it we discovered that different health conditions fell into different clusters. For example diabetics tended to fall into a cluster of their own, where the severity of the diabetic condition indicated the position between diabetic centroid and healthy subjects.

Conclusion: The finding concluded that different health conditions can be defined by the BP pulse shape clustering generates a continuous health space, cluster centroids that represent various pulse.

Biography

Ehud Baron was the Professor and Researcher in Technion at Israel Institute of Technology, Aalborg University, UC Berkeley and Stanford University. He was also a serial entrepreneur who served as a Chairman, President/CTO in Medical device companies like X-Cardio Corp. KK, Tokyo, GoldTech Sino-HK, Concardio, Inc., Cleveland and Heart Beat Technologies, Ltd., Israel and JV with LifeQ, SA, US, NL. He was also the Interventional Cardiologist at SHLV, St. Louis and Inventor of bifurcation stent that has 30 patents to his name. He serves as an Assistant Professor of Clinical Medicine in the Department of Medicine at Washington University School of Medicine.

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